FABRICATION OF GOLD NANOPARTICLES USING LOW HYDROTHERMAL REACTION FOR MEMORY APPLICATION

By

NG SOO AI

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DECLARATION

I hereby declare that I have conducted, completed the research work and written the thesis entitled “Fabrication of Gold Nanoparticles Using Low Hydrothermal Reaction for Memory Application”. I also declare that it has not been previously submitted for the award of any degree or diploma or other similar title of this for any other examining body or university.

Name of student: Ng Soo Ai Signature:

Date:

Witness by

Supervisor: Assoc. Prof. Dr. Khairunisak Abdul Razak Signature:

Date:

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LIST OF ABBREVIATIONS

AuNPs	Gold nanoparticles
Al	Aluminum
Zn	Zinc
Si	Silicon
PMSSQ	Polymethylsilsesquioxane
HMT	Hexamethylenetetramine
MIS	Metal-insulator-semiconductor
ITO glass	Indium doped tin oxide coated glass
ITO PET	Indium doped tin oxide coated Polyethyleneterephthalate
FESEM	Field emission scanning electron microscopy
EDX	Energy Dispersive X-ray Spectrometer
XRD	X-ray diffractometer
I-V	Current-voltage
C-V	Capacitance-voltage
TE	Thermionic emission
SCLC	Space Charge Limited Current
TCLC	Trapped Charge Limited Current
NVM	Nonvolatile memory

LIST OF SYMBOLS

V_{th}	Threshold voltage
ΔV_{FB}	Flat band voltage shift
>	Greater than
$\propto$	Proportional to
$\approx$	Approximately
θ	Theta
$\mathcal{E}_{PMSSQ}$	PMSSQ dielectric constant.
ε_i	Insulator permittivity
k	Boltzmann constant
$\emptyset_B$	Barrier height
μ	Carriers mobility
eV	Electron volt
λ	Wavelength

LIST OF PUBLICATIONS

Ng, S. A., Razak, K. A., Cheong, K. Y. & Aw, K. C. (2015). Growth of gold nanoparticles using aluminum template via low-temperature hydrothermal method for memory applications. Journal of Materials Science: Materials in Electronics, 1-11. (Impact factor =1.966)

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PENGHASILAN PARTIKEL NANO EMAS DENGAN MENGGUNAKAN TINDAK BALAS HIDROTERMA SUHU RENDAH UNTUK APLIKASI PERANTI MEMORI

ABSTRAK

Pembentukan partikel nano emas (AuNPs) yang bertaburan pada peranti memori adalah isu utama apabila menghadapi masalah pengecilan peranti memori. AuNPs telah berjaya dihasilkan dengan menggunakan templat Aluminium (Al) atau Zink (Zn) di atas substrat Silikon (Si) atau gelas ITO dengan menggunakan kaedah hidroterma suhu rendah. Al dan Zn telah dipilih sebagai templat kerana sempadan bijian didapati akan menjadi tempat untuk pembentukan AuNPs. Dalam penyelidikan ini, Al dan Zn telah dideposit di atas substrat Si, manakala hanya Al didepositkan di atas substrat gelas ITO. Kesan suhu penyepuhlindapan ke atas templat, tempoh tindak balas hidroterma (1-5 h), kepekatan $HAuCl_4$ (0.001-0.020 M), kepekatan $Al(NO_3)_3$ (0.01-0.20 M), dan kepekatan $Zn(NO_3)_2$ (0.01-0.20 M) pada pembentukan AuNPs telah dikaji. Hasil optimum diperolehi daripada substrat Si dengan struktur AuNPs kubik berpusat muka (FCC) dibentukkan pada Al terdiri daripada saiz partikel 80 ± 4 nm dan 42 ± 7 nm dengan 1.29 x 10^{12} dan 2.71 x 10^{12} m^{-2} kawasan kepadatan untuk AuNPs bersaiz besar dan kecil masing-masing. Sampel optima ini mempamerkan sifat memori dengan ambang voltan rendah (V_{th}) sebanyak 2.2 V dan 284 caj tersimpan untuk setiap AuNP terbentuk. Mekanisma konduksi AuNPs terbentuk dalam lapisan organik pada voltan rendah mematuhi kesan termionik dengan gabungan Schottky dan Poole Frenkel. Untuk voltan medium, mekanisma konduksi melibatkan pengaliran diikuti caj terperangkap terhad semasa (TCLC). Manakala pada voltan tinggi mekanisma konduksi adalah caj jarak terhad semasa (SCLC). Dalam usaha untuk mengkaji peranti memori yang lut sinar, taburan baik AuNPs dengan 135 ± 28 nm dan 89 ± 11 nm untuk saiz partikel besar dan kecil